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Maintenance of the Highway Infrastructure

Bridge Management

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Bridge Management

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ABSTRACT

A bridge management system is required to ensure the safety of bridges and to optimize the resources available for maintenance and rehabilitation. This paper describes the bridge management practices in Ontario and outlines the work in progress towards the development of a more comprehensive bridge management system.

The basis of the bridge management system is the computerized information contained in the Ontario Structural Inventory System (OSIS) and in the Bridge Appraisals Inventory.

The structural adequacy of bridges is ensured through inspection carried out every two years. The condition of each component is recorded and stored in OSIS. This information is used to determine the need for more detailed inspections, evaluations for load-carrying capacity, repairs, or rehabilitation. The costs of repairs, rehabilitation, or replacement are calculated and recorded in the Bridge Appraisals Inventory. The data in the two inventory systems serve as the basis of a three-year program of bridge maintenance and five- and ten-year programs for the capital construction budget.

The concepts of bridge management are most refined for decks because of the serious problems of bridge deck deterioration which have been experienced in North America. The method of repair is selected and the contract documents are prepared, following a condition survey of each structure. This ensures that bridge deck rehabilitation is based on sound engineering decision criteria.

One of the major benefits of the systematic approach to bridge rehabilitation has been the development of new materials and design details, which will lead to significant improvements in the durability of new structures.

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1/ INTRODUCTION

While there is no universally accepted definition of a bridge management system, it is generally agreed that it consists of a logical sequence of events to establish priorities and optimize the maintenance and rehabilitation budget. Bridge management systems have evolved from pavement management systems which have proven to be an effective tool in dealing with roadway problems [1]. Although bridge and pavement management techniques are similar, bridge management systems are relatively new and, consequently, not yet as sophisticated as pavement management systems. This paper describes the bridge management practices for the King's Highway System in Ontario and the progress which has been made to integrate these practices into a comprehensive bridge management system.

2/ BRIDGES IN ONTARIO

There are approximately 13 000 bridges with spans over 6 m in Ontario. Approximately 3070 are located on the King's Highway System, and the remainder are under municipal jurisdiction. The Ministry of Transportation and Communications is responsible for all the costs associated with the construction and maintenance of the bridges on King's Highways and provides subsidies for municipal bridges.

A histogram showing the date of construction of the bridges under provincial jurisdiction is given in Figure 1. About 52% of the bridges were built before 1960, and these bridges require an increasing amount of maintenance and rehabilitation. Approximately 28% of the bridges were built between 1961 and 1970. Even these newer bridges have required significant expenditures on rehabilitation, particularly for the concrete deck slabs.

Prior to 1955, most of the provincial bridges were constructed from reinforced concrete or steel, with a considerably lesser number of timber bridges. The construction of prestressed concrete bridges began in the mid-1950s. Since that time the majority of bridges have consisted of a reinforced concrete deck slab on prestressed concrete girders or a post-tensioned solid or voided slab. Typical examples are shown in Figures 2 and 3. Steel bridges have continued to be built through the period and

typically make up about 25% of the bridges built each year. Figure 4 shows the split between the various types of bridges in the province.

3/ BRIDGE MANAGEMENT CONCEPTS

As in the case of pavement management, it is useful to recognize two levels of bridge management: network management, which applies to all the bridges under one jurisdiction; and project management, which applies to individual bridges.

It is also important to define a number of terms used in bridge management [2].

A DEFECT is an identifiable, unwanted condition that was not part of the original intent of the design. Examples are cracks in concrete or corrosion of structural steelwork.

A DEFICIENCY is an identifiable, currently unwanted condition that was a part of the original intent of the design. Deficiencies occur because of changes in traffic use or improved standards. Examples of deficiencies are sharp curves, insufficient vertical clearance, and bridges with inadequate capacity.

A PRESERVATION ACTION is any work performed to extend the useful life of a component as it was originally intended. Preservation actions normally prevent or correct defects and are not intended to correct deficiencies. Since deterioration is a natural occurrence, it cannot be avoided, but it can be controlled. The objective of preservation work is to maximize the life-to-cost ratio.

An IMPROVEMENT ACTION is any work performed to correct deficiencies in any component. The deficiencies may have been contained in the intent of the original design or have developed from a change in use, such as increased traffic volumes, heavier loads, or improved safety standards. While improvement actions normally correct deficiencies, existing defects may also be corrected at the same time. Typical examples of improvement actions are bridge widening, strengthening, and the replacement of indi-

vidual components. Replacement of a structure at the same site also constitutes an improvement action.

An ADDITION is an increase in the number of bridges. Additions normally result from the construction of a new facility.

The highway network in Ontario is considered to be mature, since there is little need of major expansion. Consequently, there are few additions to the network, and the bridge construction is normally the result of local capacity improvements or the replacement of deficient or defective structures. The changing needs, combined with spending restraints, have resulted in the shift from expansion of the network in the 1960s to the preservation and upgrading of the existing network in the 1970s and 1980s. Many of the bridge management systems under development elsewhere [3,4] involve detailed consideration of the methodology for establishing priorities for upgrading geometrically and structurally deficient bridges. However, bridge management practices in Ontario over the past 20 years have resulted in a bridge population in relatively good condition, with only a small number of deficient bridges. Consequently, the bridge management system now being developed for the King's Highway bridge is primarily concerned with the preservation of the existing network.

4/ NETWORK MANAGEMENT

4.1/ Inventories

The basis of Ontario's bridge management system is an extensive computerized inventory called the Ontario Structural Inventory System (OSIS) [5]. This inventory includes all structures in the province, and the data are used to generate rehabilitation needs and funding requirements.

OSIS has sufficient capacity to store up to 750 pieces of information on each bridge and contains data required for planning, design, construction, inspection, and maintenance activities. The inventory has general information, such as the name, location, jurisdiction, and dimensions of each bridge. A coding sheet for part of this information is shown in Figure 5. When a new bridge is designed, information such as the type of bridge, the materials of construction, and design cost are entered. The

data and costs of construction are added once the structure is completed.

Information on the condition of the structure is updated every two years. Every structure on the King's Highway System is the subject of a biennial inspection, which is carried out by the staff of the Ministry's Regional Offices. All components of the bridge are inspected for defects. The extent and severity of any defects and their effect on the performance of the structure are recorded following the procedures given in the Ontario Structure Inspection Manual [6]. An example of a complete inspection form for part of a structure is shown in Figure 6.

The retrieval of data from OSIS is very flexible and can be adjusted to the end use. The data can be sorted by any particular item or by a combination of a number of items. For example, it is possible to generate a list as general as all the bridges in the province or as specific as all the steel beam bridges constructed in a specified area in a certain year.

The Highway Program Administration Office also maintains an inventory to identify deficiencies and projected new facilities. These data are contained in the Bridge Appraisals Inventory [7] and are used to develop the long term funding requirements for capital construction. An example of the data which are included in this inventory is shown in Figure 7. The costs for eliminating the defects identified in the biennial inspection and for eliminating any deficiencies are estimated by the Regional Structural Sections. Some of these data are transferred automatically to OSIS. However, since all the data are not contained in OSIS, the separate inventory is still being maintained.

At the present time, a separate inventory is also maintained for clearances and load limits on the King's Highway System. This inventory is known as the Ontario Structure Clearance and Loads Information System (OSCLIS) [8]. The output from this inventory provides a record of all structures which have low vertical or horizontal clearance or a load restriction of less than 20 t. The primary purpose of OSCLIS is to provide a data base for issuing permits for over-height or overweight vehicles.

The redundancy contained in these three inventories has been recognized, and the data will be merged into a single structural inventory to serve the needs of all users. A data base management system will be used, and single inventory is expected to be operational by mid-1986.

4.2/ Maintenance Activities, Priorities, and Funding

For technical reasons, it is convenient to divide bridge maintenance, rehabilitation, and construction into the following categories:

1/ Preservation
   a) General Maintenance (Cleaning)
   b) General Maintenance (Repair)
   c) Project Maintenance

2/ Improvement Actions

3/ Additions

General maintenance (cleaning) consists of those activities which can be considered preventive maintenance essential to extending the service life of the network. It includes cleaning debris from joints and drains and washing bearing seats. The work is required as part of the Ministry's maintenance quality standards and is carried out annually by the Ministry's maintenance forces [9].

General maintenance (repair) consists of such activities as painting structural steel, patching spalls in concrete components, and replacing deck joints or handrails. Work to be included in the general maintenance (repair) program is determined from the biennial inspection reports and OSIS. A three-year program is developed by each Regional Structural Section and updated annually. The work is carried out by either District forces or by contract. The actual work undertaken is determined annually through consultation between District and Regional staff, by taking into account the defects which have been identified and the maintenance budget for all maintenance activities (roadway and bridges). The division between work performed in-house and by contract is determined by the resources available within each District. Defects which cannot be included in the one-year work plan or where the work can be included in another future contract are deferred and considered again in the cyclical review. An example of the work to be undertaken in one District is shown in Figure 8. It indicates the priority and nature of the work, the cost,

and the division between in-house and contract work. Both categories of general maintenance are controlled through the Operational Management System and funded from the maintenance budget.

Project maintenance consists of correcting deficiencies to restore components to their original capacity and condition. It includes items such as deck rehabilitation and the strengthening of components. Project maintenance is termed capital construction work, which is funded by the Transportation Capital Branch and controlled through the Bridge Appraisals Inventory. The capital construction budget funds both roadway and bridge work, though each category is identified. Improvement actions and additions are also funded from the same budget. A comprehensive definition of the activities included in each budget category is covered by Ministry directive [10]. All the information on defects, deficiencies, and projected new facilities is used to prepare a five- and ten-year program for capital construction. The initial programs are prepared by each Region on the basis of Regional needs and priorities.

The work is grouped to minimize construction costs by developing contract packages which will attract competitive bids. This is done by including related work activities in each contract and matching the size of the contract to the expertise and equipment required for its execution. An example of part of a five-year priority list developed for the structures within one region is shown in Figure 9. It indicates the nature and cost of the work, the recommended year of construction, and comments on appropriate contract grouping.

This information is then used to assemble a province-wide capital construction program, taking into account provincial needs and priorities and available funding. The five- and ten-year programs are updated regularly in response to technical needs and changes in funding.

5/ PROJECT MANAGEMENT: THE EXAMPLE OF BRIDGE DECKS

Of all the components in a bridge, the bridge deck has exhibited the most rapid deterioration. This is particularly true in North America, where the combination of insufficient concrete cover to the reinforcement, heavy use of de-icing chemicals, and frequent freeze-thaw cycles has

resulted in most authorities having to undertake a comprehensive bridge rehabilitation program. This has been the case in Ontario, where in extreme cases, major deck rehabilitation has had to be carried out within 10 years of construction. The need to rehabilitate a large number of bridges with limited resources led to the development of procedures to ensure that the optimum method of rehabilitation is chosen for each structure. These procedures have been formalized in the Ministry's "Bridge Deck Rehabilitation Manual" [11].

Bridge deck rehabilitation consists of four essential steps:
- survey of the condition of the deck;
- planning, including selection of the method of rehabilitation;
- design, including the preparation of contract documents;
- construction.

5.1/ Detailed Deck Condition Survey

Approximately two years before the scheduled rehabilitation, a detailed deck condition survey is made. The purpose of the survey is to provide sufficient information to select the method of rehabilitation and to prepare the contract documents. A detailed deck condition survey involves a significant amount of work (approximately two days for a four-man crew on a typical 500 m^2 structure) and is not carried out unless there is a commitment to rehabilitate the structure. The detailed condition survey may be carried out either by Ministry staff or, more usually, by consulting engineers. For a bridge deck with an exposed concrete surface, the survey consists of
- a visual survey to record significant cracks, patches, and areas of scaling and spalling on the deck surface and soffit;
- measurement of corrosion potentials (1.5 m x 1.5 m grid);
- measurement of concrete cover (1.5 m x 1.5 m grid);
- inspection of the other components of the structure;
- taking cores from sound and deteriorated areas of the deck;
- photographing significant deterioration.

On decks with a bituminous surfacing, it is not possible to measure concrete cover and delamination. It is also more difficult to determine the condition of the deck slab. Consequently, more cores must be taken,

and the sections of the surfacing (approximately 250 mm x 250 mm) are removed to examine the deck surface. Since it is necessary to drill through the surfacing to measure corrosion potentials, a 3 m x 3 m grid is used to reduce cost.

The other components of the structure are inspected only so far as it is necessary to determine that other repairs need to be included in the deck rehabilitation contract. Included in the survey are the joints, drains, bearings, handrails and parapets, beams, substructure, and approaches. If significant deterioration is found in the beams or substructure components, it must be decided whether to include the work in the deck rehabilitation contract or award a separate contract.

The cores which are taken during the investigation are taken to a laboratory for examination and testing. All the costs are sketched, photographed, and subjected to a visual examination, and some are selected for testing for compressive strength, chloride content, and air-void system. A comprehensive report is prepared for each structure and includes a description and analysis of all the on-site and laboratory testing.

5.2/ Planning

In addition to the bridge deck condition survey, the following items need to be taken into consideration in planning the rehabilitation contract:

- location of the structure;
- site topography;
- traffic conditions;
- geometry of adjacent highway;
- options for staging (including detours);
- accessibility of components in need of repair;
- future plans for the highway;
- any usual features, e.g., utilities, drainage;
- need for liaison with other authorities.

The repair options which are considered are those which will prolong the life of the deck by 10 years or more. Consequently, temporary repairs, such as patching or epoxy injection, are considered to be routine

maintenance items rather than methods of rehabilitation. Consideration is also limited to work which will be done by contract awarded through a competitive tender process. Three options for rehabilitation are considered:

1/ Patch with concrete, waterproof and apply a bituminous surfacing.
2/ Concrete overlay.
3/ Cathodic protection.

5.3/ Selection of Rehabilitation Method

The selection of the repair method is the crucial step in deck rehabilitation. It includes consideration of many factors, some of which are technical, some economic, and some purely practical. The first step which has to be taken is to ensure that the completed structure will be structurally adequate to carry the service loads. It is necessary to establish that the deck can, in fact, be repaired (as opposed to replaced) and that all the elements of the structure will support any additional loading resulting from the rehabilitation.

The following factors most influence the selection of the rehabilitation method:

- the location of the structure and its importance in the highway network;
- the volume of traffic at the site and the impact of lane closures on traffic flow;
- the type of structure, its size and geometry;
- the nature of the deterioration;
- the extent of the deterioration;
- the anticipated remaining life of the structure;
- the load-carrying capacity of the structure;
- the history of deterioration and previous repairs;
- the future reconstruction program in the vicinity of the structure;
- local experience and contractor expertise.

The technical considerations in selecting the method of rehabilitation can conveniently be dealt with by examining the relative advantages and disadvantages of the three options. This has been done in Table 1. A decision matrix (given in Table 2) was developed from the information

contained in Table 1 and is used to select the method of rehabilitation. It should be noted that the decision matrix leads, by elimination, to the rehabilitation method which has the fewest disadvantages. There are some cases where the matrix may exclude all three methods. In such case, it is necessary to work through the matrix again and, on the basis of engineering judgement, examine the implications of violating each criterion in turn. The criteria deal with the technical and practical considerations, exclusive of cost. While costs are of paramount importance, the total cost of a contract is relatively insensitive to the method of rehabilitation. This occurs because items such as traffic control, expansion joint treatment, and repairs to other components are typically 50 to 70% of the total cost and are the same no matter what the method of deck rehabilitation.

The options for repair and the decision criteria were developed specifically for Ontario conditions. However, the same principles could be applied to any other set of options and the service conditions which prevail in any other jurisdiction.

The final item to be determined in the planning phase is the method of traffic control and traffic protection. Where a convenient detour exists, it is often advantageous to close a bridge during repair because this allows the contractor to operate with maximum efficiency. However, the opportunity to detour traffic is rarely available, and most contracts are carried out in stages while the bridge remains in service.

5.4/ Design

Before design begins, an engineering survey of the structure is required. This includes existing alignment, profile, and cross-sections, paying particular attention to deck joints and drainage. Contract documents are then prepared. A typical contract package includes general arrangement and detail drawings, special provisions, and a list of tender items.

The procedures for deck rehabilitation have been in place since 1978 and are working well. The main problem which has arisen is that sometimes the construction program must be changed, with the result that deck rehabilitation is delayed from the original schedule. Such changes are

inevitable in both new construction and rehabilitation work, although rehabilitation is more sensitive because the structure continues to deteriorate. In the case of delays of more than two years, it is often necessary to repeat portions of the deck condition survey and determine whether the method of rehabilitation selected is still the most appropriate.

6/ IMPACT OF REHABILITATION ON NEW CONSTRUCTION

An important benefit of the work on deck rehabilitation has been a substantial improvement in the quality of new construction. The large sums of money which were being spent on rehabilitation made it abundantly clear that it was much better to improve the durability of new structures (even though this might increase costs) than to have to undergo major rehabilitation contracts. The chief causes of premature deterioration were found to be inadequate provision against corrosion at the design stage and poor construction practices. As a result, the exposure conditions of all components of a bridge were examined and a method which would provide adequate protection against corrosion of embedded reinforcement identified. In most cases, the quality of the concrete was improved by specifying a higher strength, and the amount of concrete cover was increased. In those components directly exposed to salt, the additional precaution of using epoxy-coated reinforcing steel was taken. A summary of the Ministry's current policy for protection against corrosion is given in Table 3. Concurrent with the introduction of the changes in design were improvements in quality assurance procedures, to ensure that the design covers were achieved and good concreting practices were followed. These changes have resulted in new highway structures which have a much better durability than those which were being built as recently as 1978.

As with the case of rehabilitation, Table 3 applies specifically to Ontario conditions. The principles which were used in developing the table can be used to develop criteria for any other combination of materials or local exposure conditions.

7/ CONCLUSIONS

The bridge management system which is currently in place is satisfying immediate needs but is also in the process of further development. The short term goals of the province are

- to merge all the information on bridges into a single inventory;

- to improve the implementation of the preventive maintenance of bridges, such as the washing of bearing seats and the clearing of deck drains and joints;

- to develop methods for rehabilitating bridge substructure components so that the procedures which parallel those now used for bridge deck rehabilitation can also be applied to bridge substructures.

In the longer term, the objectives are

- to prepare a manual for principal inspections of structures (it is envisaged that the approach to such inspections will be similar to that used in Europe [12], except that only selected bridges will be inspected on a five-year cycle);

- to prepare a manual for the most common types of preservation repairs;

- to reduce the number of changes which occur in the rehabilitation program, to minimize inspection and design costs and to ensure that the optimum method of rehabilitation is used in all cases;

- to develop province-wide needs for major items of general maintenance to supplement the present three-year program;

- to develop training programs for both Ministry staff and consultants concurrently with the above initiatives.

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Table 1/ Relative Merits of Rehabilitation Methods

Rehabilitation Method	Advantages	Disadvantages
Concrete overlay	Structural component of deck slab. Relatively impermeable. Relatively long service-life. Well-suited to repair of badly spalled or scaled decks. Increases cover to reinforcing steel. Many qualified contractors.	Less suited to decks with complex geometry. Cannot bridge active cracks. Difficult to provide adequate texture on low-slump concrete surface. May not stop active corrosion.
Waterproofing membrane with bituminous concrete wearing course	Bridges active cracks. Relatively impermeable. Provides good riding surface. Applicable to any deck geometry. Many qualified contractors.	Performance highly variable. Will not stop active corrosion. Not suited to rough deck surfaces. Service-life limited by wearing course. Non-structural component of deck slab. Not recommended for grades in excess of 4% where heavy vehicles make turning or braking manoeuvres.
Cathodic protection	Stops active corrosion. Can be used on decks with active cracks. Provides good riding surface. Applicable to any deck geometry.	Presence of wearing course without waterproofing may accelerate deterioration of the concrete. Non-structural component of the deck slab. Periodic monitoring required. Service-life limited by wearing course. Specialized contractor and inspection required. Electrical power source required.

Table 2/ Decision Matrix for Selection of Deck Rehabilitation Method

Criterion	Concrete overlay	Waterproofing membrane and paving	Cathodic protection	Rationale
Delamination and spalls exceeding 10% of the deck area.		No	No	Where extensive patching is required it becomes more economical and more durable to construct a concrete overlay.
Corrosion potential more negative than −0.35 V over more than 20% of the deck area.		No		Patch repairs and waterproofing rarely reduce corrosion activity and may accelerate it.
Moderate or heavy scaling exceeding 10% of the deck area		No	No	The amount of patching becomes too expensive and consequently uneconomical.
Active cracks in deck slab.	No			Cracks active under live load or temperature change are reflected in a concrete overlay.
Remaining life of structure less than 10 years.	No		No	Additional cost of a concrete overlay or cathodic protection is not justified.
Concrete not properly air entrained.			No	Application of a bituminous surfacing (without waterproofing) may accelerate deterioration of the concrete.
Complex deck geometry. Skew exceeding 45°, curvature exceeding 10°, or changing super-elevation.	No			Concrete finishing machines (especially those used for low-slump concrete) have difficulty accommodating complex geometry.
Limited load capacity of structure*		No	No	Bituminous overlay is a non-structural component. Concrete overlay can be especially useful where the span/thickness ratio of deck slab exceeds 15.
Electrical power unavailable.			No	Power required for rectifier (unless mains, solar, wind or battery power can be provided economically.
Epoxy injection repairs previously performed and will not be removed.			No	Epoxy insulates underlying reinforcement from cathodic protection.

* Capacity after rehabilitation must be verified. Additional strengthening may be necessary.

Table 3/ Corrosion Protection Requirements for Various Structure Components

STRUCTURE COMPONENT	MINIMUM CONCRETE THICKNESS mm	MAXIMUM W/C OF CONCRETE	REINFORCING STEEL TO BE EPOXY COATED	CONCRETE COVER TO STEEL mm	OTHER REQUIREMENTS
Deck	225	0.45 (reinforced) 0.40 (post tensioned)	Top Mat	70±20 (Top Mat) 40±10 (Bottom Mat)	All decks covered with hot applied rubberized asphalt waterproofing membrane, protection board and 80 mm hot mix.
Barrier Wall	200 (Top of Wall)	0.45	All bars	70±20	
Substructure Components					
Group 1-Elements Directly Exposed to Salt Splash and/or Roadway Drainage	--	0.45	All bars within 100 mm of Exposed Face	80±20 (Exposed face)	
Group 2-Elements Indirectly Exposed to Salt	--	0.45	None	95±20 (Exposed face)	
Group 3-Elements Not Exposed to Salt	--	0.50	None	In accordance with OHBDC	

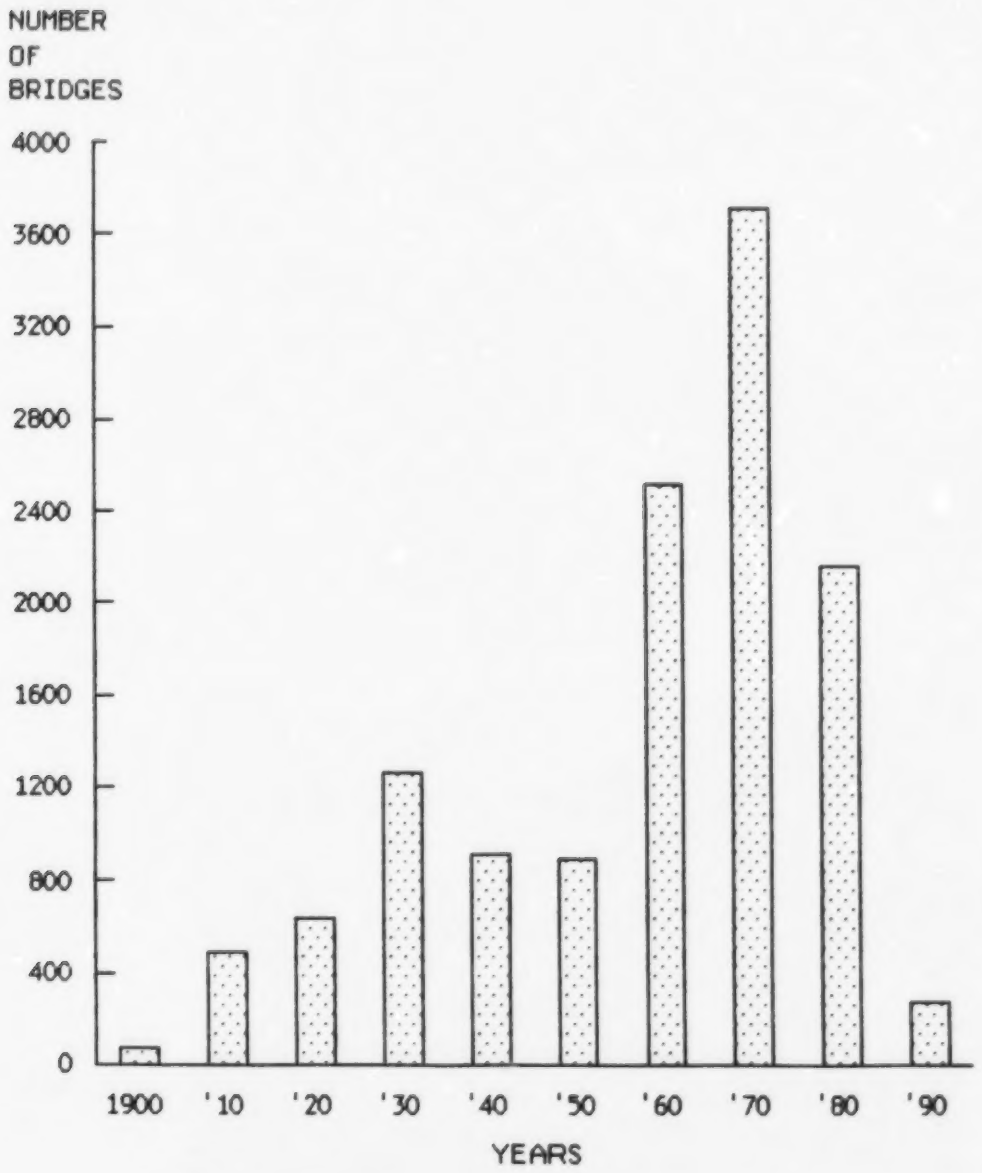

Figure 1/ Bridges in Ontario by Year of Construction

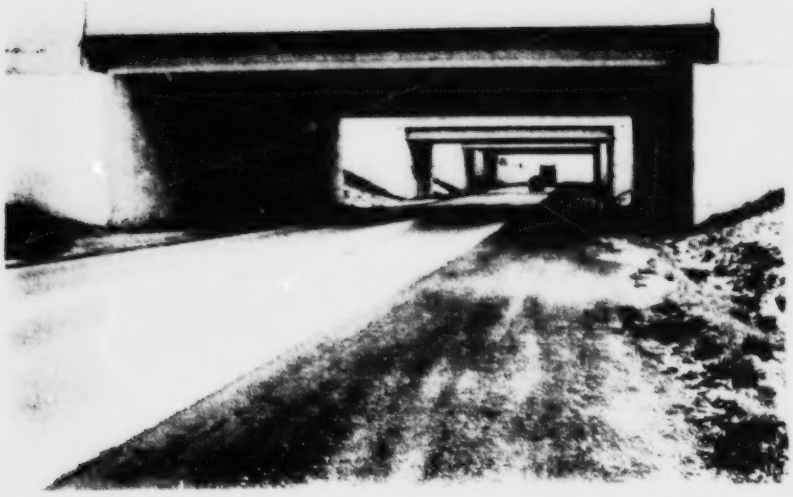

Figure 2/ Typical Precast, Prestressed Beam Bridge

Figure 3/ Typical Post-Tensioned Voided Slab Bridge

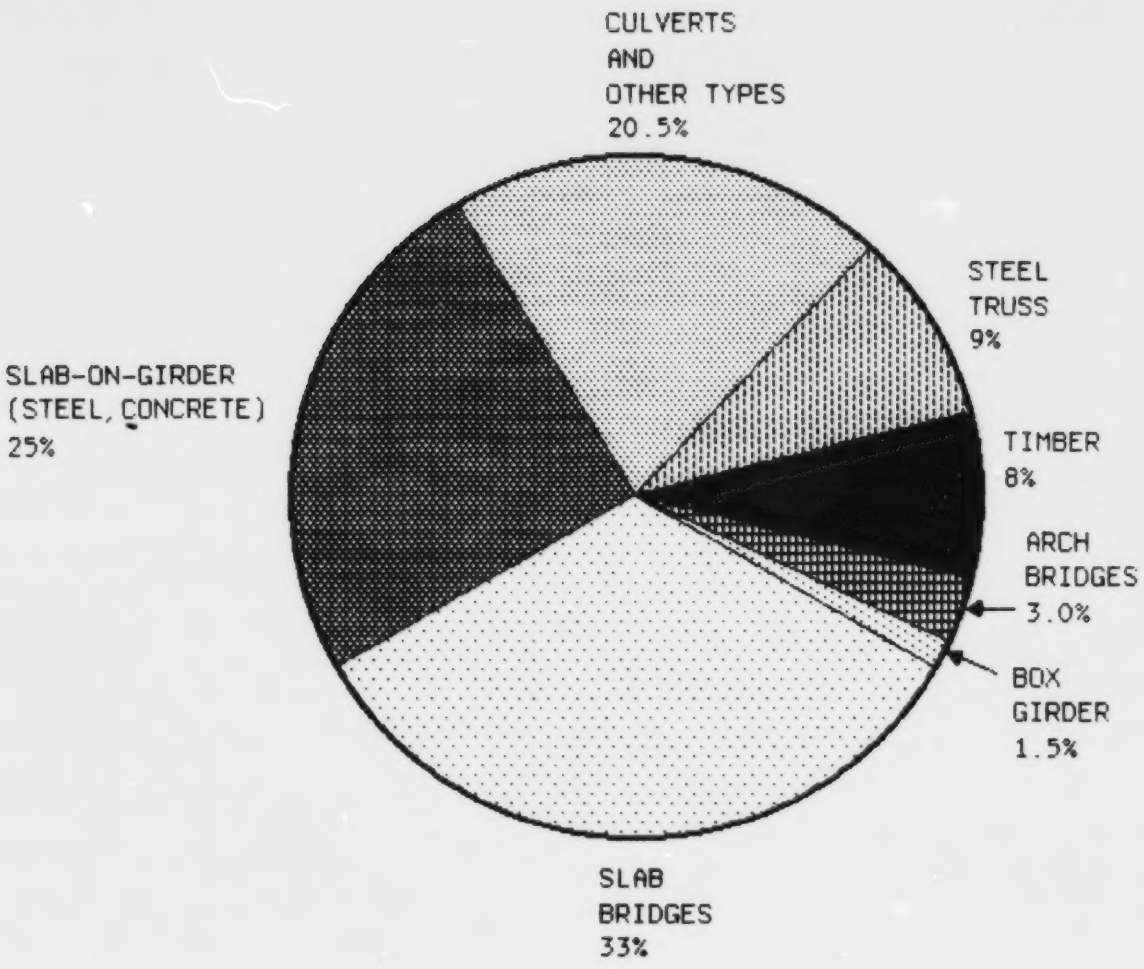

Figure 4/ Bridges in Ontario by Type

REVISED MARCH 1982

OSIS ONTARIO
STRUCTURE INVENTORY SYSTEM
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

INPUT BY / DATE | CHECKED BY / DATE | 1301-0-1

DESIGN
SHEET 1 OF 2

PUT 1 FOR BRIDGES
PUT 2 FOR CULVERTS

* PUT 0 FOR IMPERIAL
PUT 1 FOR METRIC
ENTRY MUST BE THE SAME FOR ALL CARDS (1 to 6)

SEQUENCE NUMBER	CARD NO.	*	STRUCTURE NAME	DES INITL	ADDITIONAL INFORMATION (ALPHABETIC OR NUMERIC)
1	2	3	FIELDS 4 TO 11	12	FIELDS 13 TO 22

TSO TSO

NO ALPHABETIC CHARACTERS PERMITTED FROM CARD 2 TO 6

SEQUENCE NUMBER	CARD NO.	*	CODE 1	OWNED BY	MAINT BY	PARY NO.	NO OF PARTS	COUNTY SITE NO. (cnty)	(site)	TOWNSHIP SITE NO. (twp)	(site)	W.P. or W.O.	(yr)	DISTRICT	LOT	CON.	CODE 2	HWY. OVER	CODE 3	HWY. UNDER	D. NO.	M. NO.	B. NO. or E. NO.	CONSULT or MTC CODE DESIGN BY	INPUT BY	INPUT REV. NO.	RLYBLTY CODE
	2																										
	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
		TSO																	TSO		TSO				TSO			

SEQUENCE NUMBER	CARD NO.	*	FINAL DESIGN SHED. ACTUAL (m)	OVER STRUCTURE NO OF LANES	OVER STRUCTURE MIN TOT WIDTH (m) CURB TO CURB	OVER STRUCTURE O/A WIDTH min (FT/m)	OVER STRUCTURE MIN VERT CLEAR (FT/m)	UNDER STRUCTURE NO OF LANES	UNDER STRUCTURE OPENING AVAIL (FT/m)	UNDER STRUCTURE MIN VERT CLEAR (FT/m)	BLANK	SKEW DEG.	MIN RADIUS OF CURVATURE OF DECK (FT/m)	TOTAL NUMBER OF DUCTS BELL	DUCTS LIGHT	DUCTS HYDRO	POLES LIGHT	POLES HYDRO	OIL	GAS	WATER	SEWER	CURBS	SIDEWALK	MEDIAN
	3																								
	51	52	53	54	55	56	57	58	59	60	61	62	63	FIELDS 64 TO 68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
		TSO						TSO			TSO				TSO													

Figure 5/ Coding Sheet for the Ontario Structure Inventory System

ONTARIO STRUCTURE INSPECTION MANUAL

1/ GENERAL INFORMATION

STRUCTURE NAME	SANDUSK CREEK BRIDGE	COUNTY SITE NUMBER	9-41
HIGHWAY NUMBER	3	BELOW	DIST. 4
NUMBER OF SPANS	1	SPAN LENGTH	15 m.
ROADWAY WIDTH	9 m.	DATE OF CONSTRUCTION	1935
INSPECTOR'S NAME	J. SMITH	DATE	1984
DIRECTION OF INSPECTION	NEST TO EAST	TEMP°C	20° C
EQUIPMENT USED	—	ROADWAY PROTECTION	—
SEQUENCE NUMBER		TOWNSHIP NUMBER	
LHRS NUMBER		BRIDGE NUMBER (MUNICIPAL)	
LOCATION		JURISDICTION	MTC

ABBREVIATIONS:

P	PRIMARY COMPONENT
MCP	MATERIAL CONDITION RATING
PCR	PERFORMANCE CONDITION RATING
N/W	NORTH OR WEST (CHOOSE ONE)
S/E	SOUTH OR EAST (CHOOSE ONE)

RATING SYSTEM:

6	VERY GOOD	0	COMPONENT DOES NOT EXIST
5	GOOD	9	COMPONENT CANNOT BE INSPECTED
4	FAIR		
3	POOR		
2	URGENT		
1	CRITICAL		

2/ OVERALL PERFORMANCE CONDITION RATING OF STRUCTURE

PCR - CONTROLLING PRIMARY COMPONENT WITH LOWEST P.C.R.

[2] NORTH AND SOUTH EXTERIOR BEAMS

PC - % AREA OF DETERIORATED COATING

[X]

Figure 6/ Example of Part of a Completed Inspection Form

O.S.I.M.

RECOMMENDATIONS

	YES	NO	
1	☑	☐	DETAILED DECK CONDITION REQUIRED
2	☑	☐	EVALUATION REQUIRED
3	☑	☐	LOAD LIMIT POSTING REQUIRED

4 ESTIMATED POSTING LOAD - 10 TONNES

5 REPAIRS TO BE CARRIED OUT BY DISTRICT STAFF

6 REHABILITATION TO BE DESIGNED BY REGIONAL STRUCTURAL SECTION

- REPAIR SPALLED AREAS IN ABUTMENTS, BEARINGS SEATS, WINGWALLS AND BALLAST WALLS.

- REPAIR SPALLED AREAS IN PARAPET RAIL.

- CARRY OUT A DETAILED DECK CONDITION SURVEY AND DESIGN DECK OVERLAY.

- EVALUATION REQUIRED TO CONFIRM LIMIT.

- ALTERNATIVELY COST FOR REPLACEMENT.

Figure 6/ Cont'd

8 BEAM OR GIRDER

SPAN 1

	P	MCR	PCR	PC	COMPONENT	TYPE
1	P	5	6	-	N EXTERIOR BEAM FIRST 3 m	CONCRETE
2	P	5	6	-	N EXTERIOR BEAM LAST 3 m	CONCRETE
3	P	1	2	-	N EXTERIOR BEAM REMAINDER	CONCRETE
4	P	5	6	-	S EXTERIOR BEAM FIRST 3 m	CONCRETE
5	P	5	6	-	S EXTERIOR BEAM LAST 3 m	CONCRETE
6	P	1	2	-	S EXTERIOR BEAM REMAINDER	CONCRETE
7	P	6	6	-	INTERIOR BEAM FIRST 3 m	CONCRETE
8	P	6	6	-	INTERIOR BEAM LAST 3 m	CONCRETE
9	P	6	6	-	INTERIOR BEAMS REMAINDER	CONCRETE

COMMENTS: MIDDLE PARTS OF N AND S BEAMS HAVE VERY SEVERE SPALLING OF THE CONCRETE FROM THE BEAM SOFFITS. RUSTED REINFORCEMENT SHOWING FOR 7m OF N BEAM AND 3m OF SOUTH BEAM. WIDE FLEXURAL CRACKS IN MIDDLE THIRD OF NORTH EXTERIOR BEAM. FINE FLEXURAL CRACKS IN SOUTH EXTERIOR BEAMS. INTERIOR TWO BEAMS IN GOOD CONDITION.

Figure 6/ Cont'd

PROVINCIAL STRUCTURE – APPRAISAL SHEET

CONTROL 502

DEC. 77

IDENTIFICATION

1. MTC DISTRICT
2. LHRS & OFFSET
3. LHRS & OFFSET REFERENCE OF ROAD SECTION IN WHICH STRUCTURE IS LOCATED
4. PRESENT JURISDICTION KING'S HWY ____ SEC HWY ____ TERT RD ____ CO/REG RD ____ LOCAL ____ OTHER ____
5. HWY NO
6. OVERLAPS HWY
7. ROAD NAME
8. LOCAL NAME FOR STRUCTURE
9. MTC SITE NO
10. LOCATION
11. RURAL ____ SEMI URBAN ____ URBAN ____
12. MAP NO
13. DESIRABLE JURISDICTION KING'S HWY ____ SEC HWY ____ TERT RD ____ CO/REG RD ____ LOCAL ____ OTHER ____

EXISTING CONDITIONS

14. EXISTING STRUCTURE BRIDGE ____ CULVERT ____ NONE ____
15. (A) SPAN OR DIAM ____ m (B) SKEW ____ °
16. TYPE OF CROSSING OVER WATER ____ OVER R R ____ UNDER R R ____ OVER ROAD ____ UNDER ROAD ____
17. STRUCTURE SERVES 2-WAY TRAFFIC ____ 1-WAY TRAFFIC EB ONLY ____ WB ONLY ____ NB ONLY ____ SB ONLY ____ RAMP ____
18. EXISTING TRAFFIC 19___ AADT ____ DHV% ____ DHV ____ DIR SPLIT ____ 1-WAY DHV ____ T% ____
19. FUTURE VOLUMES 19___ AADT ____ DHV ____ 1-WAY DHV ____ T% ____
20. PHF ____ 21. L O S VOLUMES 2-WAY ____ 1-WAY ____ A ____ B ____ C ____ D ____ E ____

DEFICIENCIES	EXIST. COND.	MIN. TOL.	NOT DEF.	DEFICIENT NOW	DEFICIENT 1–5	DEFICIENT 6–10	CODING BOXES
22 SAFE LOADING							
23 ROADWAY WIDTH							
24 VERTICAL CLEARANCE							
25 AVGE SAFE SPEED							0
26 LEVEL OF SERVICE							
27 SIDEWALKS							
28 OPENING ADEQUACY							

TYPE, COSTS & TIME OF IMPROVEMENTS

FIRST IMPROVEMENT

29. TYPE REPLACE SAME LOCATION ____ REBUILD OR RECOND ____ SPOT IMPROVEMENT ____ CODE BOX
REPLACE NEW LOCATION ____ WIDEN ____ NEW STRUCTURE ____
30. PROPOSED STRUCTURE SINGLE SPAN ____ MULTIPLE SPAN ____ PIPE CULVERT ____
31. FOUNDATION CONDITION GOOD ____ FAIR ____ POOR ____
32. COST PER SQ METRE $ ____
33. DECK LENGTH ____ m
34. DECK WIDTH ____ m
35. DECK AREA ____ m²
36. TIME NOW ____ 1–5 YRS ____ 6–10 YRS ____
37. TOTAL COST OF STRUCTURE $,000

SECOND IMPROVEMENT

29. TYPE REPLACE SAME LOCATION ____ REBUILD OR RECOND ____ SPOT IMPROVEMENT ____ CODE BOX
REPLACE NEW LOCATION ____ WIDEN ____ NEW STRUCTURE ____
30. PROPOSED STRUCTURE SINGLE SPAN ____ MULTIPLE SPAN ____ PIPE CULVERT ____
31. FOUNDATION CONDITION GOOD ____ FAIR ____ POOR ____
32. COST PER SQ METRE $ ____
33. DECK LENGTH ____ m
34. DECK WIDTH ____ m
35. DECK AREA ____ m²
36. TIME NOW ____ 1–5 YRS ____ 6–10 YRS ____
37. TOTAL COST OF STRUCTURE $,000

38. WP'S/CONTRACTS RELATED TO THIS STRUCTURE
39. REMARKS

40. DATE
41. BY
42. ACCOMPLISHMENT CODE

PH-A-309 77-12 (FORMERLY OB-MR-217)

FLIP

Figure 7/ Provincial Structure – Appraisal Sheet

STRUCTURE PRIORITY LIST

REGION: Central DISTRICT: _____ CAPITAL [ ] MAINTENANCE [X]

REGIONAL PRIORITY	DISTRICT PRIORITY	HWY No.	SITE No.	NAME & LOCATION	WORK REQUIRED	ESTIMATED COST		TOTAL ESTIMATED COST	PERSON-HOURS	RECOM. YEAR	REMARKS
						S&W	DOE				
1		11	39-78	Driftwood River at Monteith	Paint structural steel	4.2	35.0	39.2	400	1983	Combine into one painting contract.
2		67	39-89	Barber's Bay	Paint handrails	0.5	1.5	2.0	50	1983	
3		11	39-5	Nagagmi River	Paint structural steel	4.0	36.5	40.5	500	1984	Combine into one painting contract.
4		11	39-1	Pagwachuan River	Paint structural steel	5.0	40.0	45.0	500	1984	
5		11	39-2	Mattagami River at Smooth Rock Falls	Repair spalled abutments	2.8	1.0	3.8	280	1983	Bridge crew
6		11	39-78	Driftwood River at Monteith	Repair curbs	2.8	1.1	3.9	280	1983	Bridge crew

Figure 8/ Example of a Structure Priority List for General Maintenance (Repair)

STRUCTURE PRIORITY LIST

REGION: Central DISTRICT: CAPITAL [X] MAINTENANCE [ ]

REGIONAL PRIORITY	DISTRICT PRIORITY	HWY No.	SITE No.	NAME & LOCATION	WORK REQUIRED	ESTIMATED COST		TOTAL ESTIMATED COST	PERSON-HOURS	RECOM. YEAR	REMARKS
						S&W	DOE				
1		54	9-44	CNR overhead just N. of Hwy 3, Cayuga	Deck rehabilitation			50		1987	WP 69-81-01
2		3	9-41	Sandusk Creek Bridge	Structure replacement			175		1984	WP 246-62-02
3		420	34-34	Palmer Road Underpass	Replace superstructure			310		1985	WP 65-81-01
4		420	34-35	Ontario St. Underpass	Rehabilitation			250		1986	WP 55-81-01
5		403	36-36	Desjardines Canal Twin	Deck rehabilitation			240		1986	WP 229-77-04*
6		403	36-34	Hwy 403 southbound to Hwy 6 southbound ramp over Hwy 403	Deck rehabilitation			75		1986	*
7		403	36-33	Guelph Road overpass 1.1 km south of Hwy 6	Deck rehabilitation			56		1986	WP 229-77-02*
8		QEW	10-16	Oakville Creek Bridge	Concrete repairs and expansion joints			2000		1986	WP 85-70-01

* Group with resurfacing WP 229-77-01.

Figure 9/ Example of a Structure Priority List for Capital Construction

Ontario

Ministry of
Transportation and
Communications
Hon. Ed Fulton
Minister